SCIENCE

NEW SERIES
VOL. XLV. No. 1159

FRIDAY, MARCH 16, 1917

SINGLE COPIES, 15 CTS.
ANNUAL SUBSCRIPTION, $5.00

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE STATE GEOLOGIST AND CONSERVATION[1]

BY conservation now-a-days is meant the best use of our natural resources, without waste. Probably the responsibility of conservation rests more upon the state geologist than any other state official, because he is the one, more than any other, whose duty it is to study and inform the public upon the occurrence, quality, quantity and uses of the natural resources of the state he serves.

INEXHAUSTIBLE RESOURCES

Natural resources may be divided into two kinds: Those that are inexhaustible and those that are exhaustible. Of the former are such as sand, clay, road materials, building stone and water power. But while these and others are inexhaustible in quantity, they do not occur universally, so may become, and in most places do become, products upon which it is vitally important that the public be informed.

Here it might be well to call attention to the fact that geologists somewhat, and the public to a large extent, lose sight of the common things, in their anxiety to discover and develop the rare ones. Often a bed of shale for brick making, sand for building, gravel for concrete, or limestone for cement, fertilizer, or other purposes, is of more local importance than a bed of coal, iron ore, or some other of the less common products. A bluff of stone may stand unused for years, before some one will see its value, perhaps for railroad ballast or con-

[1] Read before the American Mining Congress, Chicago, November 16, 1916.

crete work, and not only realize from it a fortune himself, but supply a needed commodity to industry. In studying these inexhaustible materials, as well as the exhaustible ones, the state geologist must consider their quantity and quality, and the possible uses to which they can be put.

This involves such things as the conditions of supply and demand; mining or quarrying; transportation facilities for getting out the raw material, and those of converting it into the manufactured product; and such other things as bear upon its profitable utilization. The state geologist must carefully determine whether on the whole these conditions are favorable or unfavorable, for his conclusion may decide whether or not a deposit that can be worked with profit will be used at once or left unused for many years to come. It is sometimes tempting for the geologist, whether acting as an official for the public or an expert for a company, in those cases where he is doubtful as to the value of a deposit, to take the easiest way out and report unfavorably. May it not be that good property is often thus condemned? Should we not, when placed where we must pass judgment upon deposits of doubtful value, intensify our investigations to the limit of time and means and make sure of our ground, if possible? If the value can not be determined with certainty, then the favorable and unfavorable features should be fully presented.

EXHAUSTIBLE RESOURCES

In studying the exhaustible materials, the state geologist has a double duty. In the first place, it is a part of his work to make known the areas in which such actually, probably or possibly occur, to indicate their quality and character, and to make suggestions as to their development. This part of the state geologist's work has been heretofore and is yet considered his main duty. But with the probability of some of our most important products becoming exhausted in the not distant future, the geologist's duty in conserving known material is next in importance to discovering what is unknown. To this end, he should exercise the powers of his office to prevent waste of exhaustible raw material of all kinds. For example, if there is no other bureau whose duty it is to see that the least amount of coal consistent with good mining is left in the ground as pillars, etc., it plainly is the duty of the state geologist to exert himself toward bringing about mining methods by which the largest possible amount can be recovered. The same line of action will apply to oil, natural gas, the metalliferous ores, and all other exhaustible material.

Again, the state geologist should, at least to a reasonable degree, be alive to the use of by-products. This, to be sure, will take him into the field of metallurgy and chemistry, but most geologists are informed on the elements of these subjects, if they are not experts in them. We can hardly remain unconcerned and permit by-products to be wasted, on the assumption that those operating the mines should employ experts to get the most out of the raw material. If the experts are not employed, the duty of the geologist becomes all the more incumbent, for the loss, while one to the operating company, may be primarily one to the public. It may mean the waste of valuable material the public can ill afford to spare.

Recently there has been impressed upon me the lesson that it is a duty of the state geologist to look carefully into developed mines, not only to ascertain if there is not a waste of the ore for which the mine is worked, or of some possible by-product, but of material that is too important to be classed as a by-product. In the case of the

Embreeville iron mines of Tennessee, mines that have been operated intermittently for something like seventy years, it appears that there have been wasted during all that time, large quantities of zinc ore, the presence of which was only recently discovered by an employee of the mining company now owning the property. This has, during all these years, been mined with the iron, dumped with it into the furnace, and driven off as volatile matter into the air. It is not at all improbable that the value of the zinc thus wasted is greater than that of the iron recovered. For this mine has proved to contain large deposits of zinc, and is now worked for zinc, with iron as a by-product. The mines at Leadville, Colorado, have had a similar history. It is as necessary to keep our eyes open in a developed mine as on unprospected ground.

SOIL AND TIMBER CONSERVATION

While this congress does not immediately concern itself with soil conservation, the title of this paper requires me to say that in those states that are subject to rapid erosion, there is no more important duty of the state geologist than to reduce the waste from soil wash to the minimum. No one knows so well as he, the slow process of soil formation, and the rapid rate at which the hillside accumulations of many thousands of years are removed by uncontrolled running water. The education of those who till the soil to the great importance of preserving it from wash is an overwhelmingly discouraging undertaking, but notwithstanding one which we can not shirk.

In the conservation of our resources, the state geologist, possibly above all others, should look into the future and be controlled by its prospective demands. Our rapidly increasing population; the near occupancy of all our farming and pastoral lands; the possible, even probable, depletion of the soils, natural fuels and useful minerals; all these should have his most serious attention. In those states where forestry legally comes within the duties of the state geologist, an additional responsibility of the greatest importance and one that often requires much diplomacy, is placed upon him.

LEGISLATION AND CONSERVATION

The comprehensive efforts of the state geologist for conservation ultimately require him to do what he can for constructive statesmanship. It is best to attempt conservation through the education of those who earn their livelihood from our natural resources, but at times it becomes necessary to supplement this by legislative enactment. This does not of necessity mean that those engaged in placing natural products on the market are vandals, or even that they are indifferent to waste of material. Among our most ardent and practical conservationists at present are men engaged in farming, mining and lumbering. The necessity for legislation may, and often does, mean that the complete and economic utilization of a natural resource requires conformation to a broad and well-worked-out plan that must be put in operation in statewide, or it may be inter-state, proportions. In such cases, it becomes incumbent upon the state or the nation to impose such restrictions as are consistent with the most complete utilization of such product, the rights of the public, and fairness to capital.

Of such nature is the problem of water-power development in the states that possess it in large amount. This is a natural resource, the future importance of which probably the most sanguine do not realize. There are two ways of having it developed. One is the haphazard way, by which any power site can be occupied without regard to whether the available power is all util-

ized or not, without regard to whether or not it can advantageously be linked up with other sites on the same or neighboring streams, or without regard to where transmission lines go. This means the future non-utilization of a great deal of energy that will be sorely needed. The other is the systematic plan, by which all these things are worked out in detail. This means the ultimate utilization of most of the available water power, and this can be secured only by the assistance of the state through legislative enactment. As all with experience know, this is so difficult that it is well-nigh hopeless. Likewise, conservation of forests, fuel supply and possibly the soil, need to be encouraged by legislative enactment. In part or all of these, depending upon the scope of his duties as defined by statute, the state geologist is expected to take the initiative, by deliberately calling the attention of those charged with administrative and legislative affairs to those resources which the state can aid in conserving.

THE SCIENTIFIC SPIRIT

The object of most legislators in supporting geological surveys is to develop the natural resources; that is, to increase the wealth of the state. We have no fault to find with this attitude, and we willingly exert our energies to that end; but geological work, whether for economic or scientific purposes, requires the strictly scientific spirit as its impelling force, without which no results can be relied upon. For this reason we must ask the public to indulge us if, occasionally, a bulletin appears that does not seem to have economic importance. Such may in the end prove to be of the greatest economic value. The state geologist should be a man who can make his work practical, but he should at the same time be a scientist with irresistible inclinations toward the purely scientific problems that confront him. Only such a geologist can effectually serve a state.

A. H. Purdue
State Geological Survey,
Nashville, Tenn.

STANFORD MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The second annual meeting of the Pacific Division of the American Association for the Advancement of Science will be held at Leland Stanford Junior University during the period, April 4 to 7.

General Sessions.—Among the general sessions of the division on this occasion will be the address of the retiring president of the division, Dr. J. C. Branner, president emeritus of Leland Stanford Junior University, on the evening of Thursday, April 5. Dr. F. J. E. Woodbridge, professor of philosophy at Columbia University and lecturer in philosophy on the Mills Foundation at the University of California this spring, will present an address on Friday evening, April 6, on the subject, "History and Evolution." This address will be followed by a general reception on the part of the university to the visiting members of the American Association and of affiliated societies.

On Thursday afternoon, April 5, a symposium will be held upon the general subject, "Coordination and Cooperation in Research and in Applications of Science," under the direction of Dr. D. T. MacDougal, director of the Desert Laboratory of the Carnegie Institution of Washington, at Tucson. Among the speakers at this symposium will be Dr. William E. Ritter, director of the Scripps Institution for Biological Research, at La Jolla, who will present a paper on "Closer Organization of Scientific Men of the World."

Meetings of Societies.—The following announcements are made concerning the meetings of societies participating in this occasion.

On Saturday evening, April 7, a dinner will

be given in San Francisco under the auspices of the California Academy of Sciences, at which the visiting members of the American Association and of affiliated societies will be welcome. The president of the academy, Mr. C. E. Grunsky, of San Francisco, will preside, and a number of men of science in various fields of investigation have been invited to give informal addresses.

The Astronomical Society of the Pacific will hold sessions on Thursday and Friday, April 5 and 6. Some twenty papers are expected from the staff members of the Lick Observatory, the Mount Wilson Solar Observatory, the department of astronomy at the University of California, and from others. A feature of especial interest will be a paper by Dr. George E. Hale, director of the Mount Wilson Solar Observatory, covering many details of the investigational work being carried on at this observatory, illustrated with motion pictures.

The Pacific Section of the American Mathematical Society will hold sessions on Saturday, April 7.

The American Physical Society will hold sessions on Saturday, April 7, and a dinner for physicists will be arranged at Stanford University for Saturday evening.

The California Section of the American Chemical Society will hold sessions on Saturday, April 7.

The Cordilleran Section of the Geological Society of America will hold sessions on Thursday and Friday, April 5 and 6. Certain of the sessions will be correlated with those of the Seismological Society of America, and of the Pacific Coast Branch of the Paleontological Society of America, which will also meet upon the same days. The program of the Seismological Society will include a paper by Dr. H. O. Wood, of the Hawaiian Volcano Observatory, on "The Earthquake Problem in Western United States," and a paper by Mr. A. H. Palmer, of the United States Weather Bureau, San Francisco, on "Earthquakes in California in 1916." An extensive program for the Paleontological Society is in preparation dealing with Tertiary faunas of the Pacific coast and the influence of climate upon certain of these faunas.

The Le Conte Club will hold its customary dinner for geologists, paleontologists, geographers and seismologists on the evening of Friday, April 6.

The Western Society of Naturalists will hold sessions on Friday, April 6. Contributions from members of the society will occupy the morning session of Friday and the afternoon session will be devoted to a group of special papers upon the general topic, "The Present-Day Bases for the Evolution Theory."

On Saturday, April 7, an excursion will be conducted, under the auspices of the Zoological Field Club of Stanford University, to the recently completed bungalow of this club in the Coast Range foothills, which all visiting members of the biological societies participating in this meeting are cordially invited to attend. Members of the Cooper Ornithological Club will also join in this excursion.

The Pacific Slope Branch of the American Association of Economic Entomologists will hold sessions on Thursday and Friday, April 5 and 6.

Headquarters and Registration.—The registration headquarters of the Pacific Division for this meeting will be in the rotunda of the zoology building, Stanford University. All those attending sessions of the Stanford meeting, whether members of the American Association or participating societies or not, are requested to register at the headquarters office, and to secure there the general program for the meetings.

Mail and Telegrams.—Mail for persons attending the Stanford meeting should be addressed in care of the American Association for the Advancement of Science, Stanford University, California. Attention is called to the fact that mail should be addressed to the post office known as "Stanford University," and not to Palo Alto, while telegrams should be sent to the Palo Alto office of the Western Union Telegraph Company, marked, "to be delivered at Stanford University, care of the American Association for the Advancement

of Science." Every effort will be made to deliver promptly all mail and telegrams thus addressed to those who have registered.

Election of Officers.—According to the provisions of the constitution of the Pacific Division of the American Association, the election of three members of the executive committee from nominations prepared by a duly appointed nominating committee or received from the floor at the time of election will be held at the evening session of the Pacific Division on Thursday, April 5, preceding the general address of that evening.

Papers and Abstracts.—Those desiring to offer papers at the sessions of any of the participating societies should submit the titles of their papers to the secretaries of their respective societies at as early a date as possible, in order to be accorded a place upon the program. Abstracts limited to 300 words should also be forwarded with the titles of the paper. In case the papers are of a technical nature second abstracts in popular phraseology are requested which may be used in the press reports of the meetings.

Hotel Accommodations.—Rooms may be secured at moderate rates in Encina Hall on the campus of Stanford University by those who wish to stay over night at the university. Applications for lodging should be made in advance to Professor J. P. Mitchell, Stanford University, California. Among hotels in Palo Alto may be mentioned the following:

	Rates per Day, Single Room	European Plan, Double Room
Palo Alto Hotel	$1.00	$1.50
Hotel Larkin, without bath	1.00	1.50
with bath	1.50	2.50

University Hotel, single rooms 50c., 75c. and $1.00.

Railroad Rates.—It has not been possible to make satisfactory arrangements for special railroad rates on the occasion of this meeting. Members are advised to inquire of local agents for round-trip rates which may be in force at the time of the meeting, or to make use of mileage books.

SCIENTIFIC EVENTS

ADVISORY BOARD ON WILD LIFE PROTECTION IN CANADA

The Canadian government, by an order in council dated December 28, 1916, has appointed an interdepartmental advisory board on life protection for the purpose of formulating plans regarding the protection and use of the wild life—by which term is meant the furbearing and big game mammals, the wild fowl and other animal life—of the northwestern territories, and of advising in the administration of the Northwest Game Act and of the legislation under the recently ratified international treaty for the protection of migratory birds in Canada and the United States, and generally, for the purpose of advising it on questions relating to the protection of and use of wild life in Canada. The advisory board is constituted as follows: James White, assistant to the chairman of the commission of conservation; D. C. Scott, deputy superintendent general of Indian affairs; Dr. C. G. Hewitt, Dominion entomologist; Dr. R. M. Anderson, geological survey; J. B. Harkin, commissioner of Dominion parks.

Mr. James White is chairman and Dr. Hewitt is secretary of the board; Mr. White and Dr. Hewitt are also representatives of the government on the permanent consultative commission for the international protection of nature.

PROFESSOR BLANCHARD ON THE GEOGRAPHY OF FRANCE

Dr. Raoul Blanchard, professor of geography at the University of Grenoble, and exchange professor at Harvard University, is now delivering a series of lectures on urban geography. The cities to be considered in this course are: Lyons, Marseilles, Bordeaux, Rouen, Nantes, Nice, Nancy, Lille and Grenoble.

After a careful detailed description of the geography of the region tributary to each city, and of the exact site of the city, Professor Blanchard sketches the history, emphasizing how the geographic conditions in the environs, and the immediate conditions within the boundaries of the city, have influenced the

industrial development. The lectures are very suggestive to American geographers and historians.

Later, Professor Blanchard will give a series of lectures on the geography of the French Alps, and, if time permits, will speak on the geographic factors which have influenced the European war. These lectures are given under the auspices of the department of geography, and members of the profession are welcome as guests.

Professor Blanchard is giving the following lectures in the Lowell Institute series at 5 P.M., in Huntington Hall, Boston:

March 13. "Battle of Charleroi and Morhange."

March 16. "Battle of the Marne."

March 20. "Fixation of the Front: Aisne, Yser, Ypres, Artois, Champagne."

March 23. "Battle of Verdun."

March 27. "Battle of the Somme."

March 30. "Evolution of the Tactics and Armaments from August, 1914, to December, 1916."

THE HAYDEN MEMORIAL AWARD

AT the last meeting of the Academy of Natural Sciences of Philadelphia the gold Hayden Memorial Geological Medal was, on the recommendation of the council and the special committee on the award, of which Dr. R. A. F. Penrose, Jr., is chairman, voted to William Morris Davis, Ph.D., emeritus professor of geology in Harvard University, in recognition of his distinguished work in the science of geology. The medal is awarded every third year "for the best publication, exploration, discovery or research in the sciences of geology and paleontology, or in such particular branches thereof as may be designated."

The award as first defined in 1888 took the form of an annual bronze medal and the balance of the income of the fund. The deed of gift was modified in 1900 so as to provide for a gold medal every third year.

The awards so far made are as follows:

James Hall, of Albany, N. Y., 1890.
Edward D. Cope, of Philadelphia, 1891.
Edward Suess, of Vienna, 1892.
Thomas Henry Huxley, of London, 1893.
Gabriel August Daubree, of Paris, 1894.
Karl A. von Zittel, of Munich, 1895.
Giovanni Capellini, of Bologna, 1896.
A. Karpinski, of Petrograd, 1897.
Otto Martin Torell, of Stockholm, 1898.
Gilles Joseph Gustave Dewalque, of Liege, 1899.
Archibald Geikie, of Edinburgh, 1902.
Charles Doolittle Walcott, of Washington, 1905.
John Mason Clarke, of Albany, 1908.
John Casper Branner, of Stanford University, 1911.
Henry Fairfield Osborn, of New York, 1914.
William Morris Davis, of Cambridge, 1917.

COMMITTEES OF THE NATIONAL RESEARCH COUNCIL

THE following committees have been arranged:

Military Committee: Charles D. Walcott, chairman. From the Army: William C. Gorgas, William Crozier, George O. Squier. From the Navy: David W. Taylor, Robert S. Griffin, James D. Gatewood, and Howard E. Coffin, Van H. Manning, Charles F. Marvin, S. W. Stratton.

Research in Educational Institutions: George E. Hale, chairman.

Promotion of Industrial Research: J. J. Carty, chairman.

Nitrate Supply: Arthur A. Noyes, chairman.

Census of Research: S. W. Stratton, chairman.

Chemistry: Marston T. Bogert, chairman. C. L. Alsberg, L. H. Baekeland, A. A. Noyes, W. A. Noyes, T. W. Richards, Julius Stieglitz, W. R. Whitney.

Physics: R. H. Millikan, chairman. J. S. Ames, F. B. Jewett, J. Langmuir, Theodore Lyman, C. E. Mendenhall, Ernest Merritt, M. I. Pupin, S. W. Stratton, Arthur G. Webster.

Astronomy: E. C. Pickering, chairman.

Botany: J. M. Coulter, chairman.

Zoology and Animal Morphology: E. G. Conklin, chairman.

Medicine and Hygiene: V. C. Vaughan, chairman. Frank Billings, Chas. F. Craig, David L. Edsall, Simon Flexner, Frederick P. Gay, John Howland, Reid Hunt, Theodore Janeway, W. W. Keen, Wm. J. Mayo, George W. McCoy, Richard M.

Pearce, Milton J. Rosenau, Edward R. Stitt, Wm. H. Welch, H. Gideon Wells.

Agriculture: Raymond Pearl, chairman. Edwin W. Allen, Carl L. Alsberg, Henry P. Armsby, Eugene Davenport, Edward M. East, L. O. Howard, L. R. Jones, Whitman H. Jordan, Karl F. Kellerman, Jacob G. Lipman, L. B. Mendel, Erwin F. Smith, Theobald Smith, W. J. Spillman, William M. Wheeler.

Physiology: W. B. Cannon, chairman.

Geography: W. M. Davis, chairman.

Geology: John M. Clarke, chairman.

Anthropology: Wm. H. Holmes, chairman.

SCIENTIFIC NOTES AND NEWS

In accepting the resignation of Professor R. C. Carpenter from the faculty of Sibley College, Cornell University, the trustees have adopted the following resolution:

Resolved, that the trustees in accepting the resignation of Professor Carpenter, express their high appreciation of his services to the university for nearly thirty years. As a pioneer in the field of experimental engineering he is held in the highest esteem by all mechanical engineers, and by his writings in this field he has made an assured place for himself in the annals of his profession. As a teacher and investigator he is affectionately remembered by many generations of students and his retirement from the faculty of Sibley College will be viewed with great regret by all of his colleagues.

The portrait of Professor R. D. Salisbury, planned for by his former students, was presented to the University of Chicago on the afternoon of February 8. Dr. T. C. Chamberlin gave a sketch of Professor Salisbury's life, emphasizing his early work as a student and his contribution as a man of research. Professor W. W. Atwood, of Harvard University, spoke in behalf of the students, emphasizing the great work of Professor Salisbury as an educator and formally presented the portrait to the university. Professor Salisbury, at the request of President H. P. Judson, who presided, replied briefly, and on behalf of the university the president accepted the gift.

Dr. Joseph A. Blake, formerly professor of surgery in Columbia University, who has rendered distinguished services at Neuilly and at Ris-Orangis, has accepted an invitation from the French government to become head of the great Doyen Hospital.

The officers of the Illinois State Academy of Science elected for the ensuing year are as follows:

President, Dr. J. C. Hesler, James Millikin University, Decatur.

Vice-president, J. H. Ferris, Joliet.

Treasurer, Professor T. L. Hankinson, Eastern State Normal School, Charleston.

Secretary, Professor J. L. Pricer, State Normal University, Normal.

The following officers of the Chemical Society, London, for 1917–18, have been proposed by the council: *President,* Professor W. Jackson Pope; *New Vice-presidents,* Colonel A. Smithells and Professor Sydney Young; *New Ordinary Members of Council,* Professor H. C. H. Carpenter, Professor A. Findlay, Professor A. Harden and Dr. T. A. Henry.

Mr. F. J. Cheshire has been elected president of the Optical Society, London.

A gold medal has been awarded by the French government to Professor Landouzy for his long and ceaseless study of tuberculosis and means to combat it.

Dr. Roy G. Pearce, formerly assistant professor of physiology, college of medicine, University of Illinois, Chicago, is now a member of the research laboratory of the medical clinic, Lakeside Hospital, Cleveland. Dr. Stanley P. Reiman, formerly resident pathologist, Lakeside Hospital, has been appointed Hanna research fellow in pathology in the school of medicine, Western Reserve University.

Dr. Robert Grant Aitken, astronomer in the Lick Observatory, has been granted by the University of California four months' leave of absence to go to the Atlantic coast to complete arrangements for the publication of his work on the double stars.

Henry Hinds, geologist and acting chief of the section of eastern coal fields of the U. S. Geological Survey, has left the government service temporarily in order to take up private oil work in Costa Rica and neighboring republics.

DR. A. J. CARLSON, professor of physiology in the University of Chicago, read a paper at the February meeting of the Kansas Chapter of Sigma Xi on "The Nature of the Hunger Mechanism."

ON the evening of March 24 Professor Wallace W. Attwood, of Harvard University, will conduct a lecture conference at the Brooklyn Institute of Arts and Sciences on "Gold Mining in Alaska." The lecture will be illustrated.

DR. W. S. COOPER, of the University of Minnesota, gave a lecture on February 23 before the Geographic Society of Chicago on "The Vegetation of the Glaciers of Alaska." On March 23, Professor Robert G. Aitken, of the Lick Observatory, will speak on "The Work of two Mountain Observatories."

MR. A. CASTON CHAPMAN delivered a lecture, entitled "Some Main Lines of Advance in the Domain of Modern Analytical Chemistry," to the Chemical Society, London, on March 15. Dr. Horace T. Brown will lecture on "The Principles of Diffusion: their Analogies and Applications," on May 17.

THE library of the late Professor Hugo Münsterberg has been given to Harvard University by a group of his friends. The library consists of about 10,000 books, reprints, pamphlets, manuscripts, charts and other papers. Among the 3,000 books in the collection are the latest and most valuable ones on experimental and applied psychology, especially those bearing on phases of the subject to which Professor Münsterberg had devoted his time.

GEORGE MASSEE, formerly of the Royal Botanic Garden, Kew, died on February 17, at the age of sixty-seven years.

DR. A. BATTELLI, professor of experimental physics at the University of Pisa and a member of the Italian national legislature, has died at the age of fifty-five years.

DR. FRIEDRICH HAHN, who occupied the chair of geography at Königsberg, has died at the age of sixty-five years.

THE National Canners' Association has offered Harvard University the sum of $20,000 annually for a period of three years to carry on an investigation of food poisoning or so-called ptomaine poisoning, with special reference to canned goods. The offer has been accepted by the university, with the understanding that the investigation shall be conducted and the results thereof published with entire academic freedom. The study will be made at the Medical School under the direction of Dr. M. J. Rosenau, professor of preventive medicine and hygiene. The national research council of the National Academy of Sciences is supervising the investigations on this subject. The advisory committee of the council consists of Professors John J. Abel, of Johns Hopkins University; Reid Hunt, of Harvard University; H. Gideon Wells, of the University of Chicago; Eugene Opie, of Washington University; Lafayette B. Mendel, of Yale University, and Frederick T. Novy, of the University of Michigan.

THE council of the New York Academy of Sciences has voted that because of the unsettled condition of our international affairs the Centennial Celebration, planned for the second week of the coming May, be deferred without date. It was, however, voted that a centennial meeting be held some Monday evening in May at which emphasis will be placed on the history of the academy. The president was authorized to obtain a speaker for this Centennial Meeting; and was requested, in consultation with the other members of the committee on history to prepare a digest of historical data for the occasion.

THE lieutenant-governor of the Punjab laid the foundation stone of the new building of the Society for Promoting Scientific Knowledge at Lahore on January 30. The site for the new headquarters of the society has been given by the Lahore municipality and a sum of Rs. 14,000 has been raised by subscription.

THE department of chemistry of the New York City College, of which Professor Charles Baskerville is the head, has announced a series of lectures to be offered during the spring semester. These lectures are open to the public, and will be held on Friday afternoons at three o'clock in the Doremus Lecture Theater, 140th Street and Convent Avenue. The following is the list of lectures. February 16, "From Ore

to Finished Pipe" (illustrated with motion pictures), by Mr. C. F. Roland, New York representative, metallurgical department, National Tube Co. March 2, "New Method for Nitrogen Fixation," experimental, showing utilization of home-made apparatus, by Dr. J. E. Bucher, professor of chemistry, Brown University. March 16, "Chemical Structure and the Biological Function of Tissue Elements," by Dr. P. A. Levene, Rockefeller Institute. March 23, "The Conservation of Pine Forests through the Methods of Chemical Research" (illustrated by specimens and stereopticon), by Dr. Chas. H. Herty, editor of the *Journal of Industrial and Engineering Chemistry*. March 30, "The Getting of Wisdom," by Dr. H. K. Mees, director research department, Eastman Kodak Co. April 13, "Colloids in Pharmacy" (illustrated and experimental), by Dr. John Uri Lloyd, manufacturer, chief chemist, investigator and novelist. April 27, "Some Chemistry of the Tropics" (illustrated from recent observation), by Dr. L. H. Friedburg, professor emeritus of the College of the City of New York.

Dr. Thomas H. Haines, professor of nervous and mental diseases at Ohio State University, has five months' leave of absence from his work at the university and from the Bureau of Juvenile Research, and is making a state survey of mental defectives in Kentucky. A state commission on the feebleminded was appointed in May, 1916, by Governor Stanley in accordance with a resolution adopted by the General Assembly in March, 1916. Dr. Haines was appointed director of the survey and sent to the commission in Kentucky by the National Committee for Mental Hygiene, and the Rockefeller Foundation, without cost to the state of Kentucky. Kentucky presents a peculiarly fertile field in which to secure social economics in the management of defectives. By the terms of the Pauper Idiot Act, the substance of which has been on the statute books since the second year of the commonwealth, 1793, any person who is proved to be without estate and mentally feeble, to the satisfaction of a jury, and is so certified to the state auditor, may draw annually from the state treasury, through his committee seventy-five dollars for his maintenance. Last year more than twenty-two hundred such pauper idiots cost Kentucky by this means alone $165,000. This method is said to encourage the propagation of the mentally incompetent.

Mr. and Mrs. Gilbert H. Grosvenor have given to the American Association to Promote the Teaching of Speech to the Deaf a trust fund of $5,000 to establish an "Alexander Graham Bell Grosvenor Memorial Fund," in memory of their second son, who died March 6, 1915. In accepting this memorial fund the directors resolved that the income shall be used in paying for the publication and distribution of literature that will help parents to intelligently train and teach deaf children in the home prior to school age, and that every publication paid for from the income of this fund shall bear on the title page an inscription stating that it is a publication of the Alexander Graham Bell Grosvenor Memorial Fund. Following a suggestion from the donors, the directors decided to offer $300, a sum equivalent to the first year's income, for the best essay on the subject of "Teaching and Training Little Deaf Children in the Home." A decision on the essays submitted will shortly be made by the judges, who are Mr. and Mrs. Edmund Lyon, Rochester, N. Y., Dr. and Mrs. A. L. E. Crouter, Mr. Airy, Philadelphia, Pa., and Mr. and Mrs. Gilbert H. Grosvenor, Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS

Washburn College at Topeka, Kansas, has just added $500,000 to its permanent endowment fund. Of this sum $200,000 was contributed by citizens of Topeka, $200,000 consists of contributions secured by President Womer outside of Topeka and $100,000 was given by the General Education Board.

The University of California is to receive $10,000 as a library endowment by bequest from Horace Davis, president of the university from 1888 to 1890.

It has been decided to make the erection of new science buildings for the University College of North Wales, Bangor, the North Wales

memorial to men fallen in the war. The cost of the scheme will be £150,000.

WE learn from *Nature* that Mr. D. M. Forbes, who died on December 13 last, has bequeathed to the University of Edinburgh his books relating to the Philippine Islands, and the residue of his property, which, with the property abroad, will amount, it is understood, to about £100,000, for the purposes of education.

THE council of the University of Liverpool has recently received from a donor who desires to remain anonymous a sum of money sufficient partially to endow a chair of geography. The council has felt justified, under the circumstances, in establishing the chair, and a professor will be appointed in a few weeks.

WALTER A. PATRICK, Ph.D. (Göttingen), of Syracuse University, has been appointed associate in chemistry at the Johns Hopkins University. After two years spent in physical chemical research at the Massachusetts Institute of Technology, Dr. Patrick spent a year with Freundlich, at Braunschweig, a year with Zsigmondy at Göttingen and a year as private assistant to Professor Donnan, at University College, London.

DR. HOWARD T. KARSNER, professor of pathology, has been elected secretary of the school of medicine, Western Reserve University. Dr. Russell J. Collins, demonstrator of pharmacology, has resigned because of ill health.

THE University of Cambridge will hereafter grant the degrees of master of letters and master of science for somewhat the same qualifications as the doctorate of philosophy is awarded by German and American universities. A proposal that the degree of doctor of philosophy be awarded was rejected.

DISCUSSION AND CORRESPONDENCE

WHEN IS A FORCE NOT A FORCE?

THE article by Mr. Gordon S. Fulcher in SCIENCE for November 24, 1916, calls attention in a most timely way to the vagueness which characterizes the discussion of the idea of force in most of our modern text-books of physics, but does not make clear just how he would "use force only in the single definite sense implied in the laws of motion." Let us take the following simple case: a ball is attached to a rubber cord, say three feet in length. A person grasps the ball and pulls it with a force F, stretching the rubber cord to a length of five feet. The strain in the cord is produced by the two forces $+F$ and $-F$ acting at the ends of the cord. The third law of motion covers the case.

Now suppose the person swings the ball around his head at the end of the rubber cord until its velocity is great enough to stretch the cord again to a length of five feet. The stress in the cord is the same as before. The question is, what is the nature of the "reaction" which the ball is exerting on the cord to stretch it? It is certainly a "force" F (otherwise the cord would not be stretched as it is), and it is in one sense balancing the equal "action" of the cord on the revolving ball, which we know as centripetal force. Is the "centrifugal force" (inertia-reaction of the ball) in this case a force in the "single definite sense implied in the laws of motion"? Does the third law also cover this case?

We usually define force as that which produces (or tends to produce) a change in the condition of motion of a mass, either in magnitude or in direction. Certainly inertia-reaction might not come under this definition, but undoubtedly our definitions of force are intended to describe ordinary forces—mechanical, magnetic, electrical, etc.—which can do three things: (1) oppose other forces, (2) produce acceleration, and (3) produce deceleration. The force called friction can do only the first and third of these things; it can not produce acceleration (except in indirect ways). Is friction a force in good and regular standing in the "single definite sense implied in the laws of motion"?

Inertia-reaction can do only the first of these three things; it can not, by its very nature, produce either acceleration or deceleration. And yet even while it is opposing the restoring stress in the rubber cord mentioned above, we

call the force exerted by the cord, because it produces centripetal acceleration, an "unbalanced force."

What is the average student to make of it when he is told in one of our best texts that "force is exerted only while the motion is changing," and yet on the next page reads "a locomotive pulling a train with uniform velocity along a level track exerts force" on the train?

Or when in another text he is told that to *every* action there is *always* an equal and contrary action, and is then informed that an *unbalanced force* acting on a mass produces acceleration?

Or when he reads in one of the very best of our first-year texts that "forces always occur in pairs, one of the pair being equal and opposite to the other," and yet is told a little farther on that "by an unbalanced force we mean more push or pull in one direction than the other"?

Why can not we frankly admit that inertia-reaction acts in one respect like a force, and is actually a kind of force, even if we continue to use the term "unbalanced force" in the sense of *a force opposed only by inertia-reaction?* A porter pushing a heavily laden truck at uniform speed feels the reaction due to friction; if the friction suddenly vanished, he would feel the reaction due to the inertia of the truck. He might not know the difference, except that in the latter case he would succeed in giving the truck a small acceleration. But he would doubtless be greatly astonished to learn that in the first case his push was balanced by an equal counter-force, while in the second case his push was an "unbalanced force"!

The writer finds that the clearest (if somewhat tautological) definition of force for the average student is *that which produces motion, change of motion, compression and tension.* Under this definition the inertia-reaction of the ball revolving at the end of the rubber cord is a force, because it produces tension in the cord.

Inertia-reaction can oppose other forces, it can in that sense balance them, but it can not hold them in equilibrium, because a force opposed only by inertia-reaction always produces acceleration, positive or negative, and may for that reason be called an unbalanced force.

If the drawbar pull of a locomotive is 1,000 pounds, and the sum of the opposing forces due to the friction of the wheels, journals, wind, etc., is 600 pounds, we may say that the unbalanced force exerted by the engine on the train is 400 pounds, and this produces acceleration. *But the pull on the drawbar is the same in both directions*—it is manifestly impossible for it to be otherwise—and the backward pull is made up of 600 pounds of frictional forces and 400 pounds of inertia-reaction.

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SCIENTIFIC BOOKS

Diseases of Occupation and Vocational Hygiene. Edited by G. M. Kober and W. C. Hanson. P. Blakiston's Son & Company. Philadelphia, 1916. Octavo. Pp. xxi + 918. $8.00.

Ten years ago there was no such thing as a science of industrial hygiene in the United States. During the last half of the decade Dr. Alice Hamilton, Dr. G. M. Price, Dr. E. R. Hayhurst, Mr. F. L. Hoffman and others have conducted fundamental and important investigations in this field; the American Association for Labor Legislation has organized an educational campaign which has resulted in unparalleled legislative advances; and during the past two years three good textbooks have appeared dealing with the subject —Dr. G. M. Price's "The Modern Factory," Dr. W. Gilman Thompson's "The Occupational Diseases," and the volume under discussion—besides a wealth of monographs on accident prevention and other special phases of the subject.

"Diseases of Occupation and Vocational Hygiene" is the most ambitious of these works, having been prepared under the editorship of Drs. Kober and Hanson by thirty-one American and foreign specialists in various branches. Many of the topics are so treated

as to make noteworthy contributions to the science of industrial hygiene. Dr. T. M. Legge's section on Arsenic Poisoning is the best brief treatment of this subject known to the reviewer. Dr. E. R. Hayhurst's discussion of brass and zinc poisoning, Dr. G. L. Apfelbach's treatment of carbon monoxid poisoning, Dr. Hamilton's review of lead poisoning in the United States and Dr. Louis Casamajor's section on manganese poisoning all embody in compact form original researches of the authors which have been made under American conditions and with such thoroughness as to be of substantial and permanent value. Professor F. S. Lee's chapter on Fatigue and Occupation is a notable contribution to the subject, and Dr. J. T. Bowen's discussion of occupational affections of the skin contains much valuable material. Dr. L. Devoto's account of his famous clinic for occupational diseases at Milan, Professor G. C. Whipple's brief discussion of the use and the fallacies of statistics, and the sections on factory legislation by Mr. John B. Andrews, by the late Professor C. R. Henderson and by Mr. C. H. Crownhart, are deserving of specially favorable mention.

With the virtues of an encyclopedic work prepared by many authors there necessarily goes a certain lack of balance and proportion, aggravated in this case by the somewhat artificial separation of the diseases themselves from their etiology and prophylaxis which leads to the discussion of arsenic poisoning, brass poisoning, etc., in two different places in the book and often by different authors, with some consequent repetition and confusion. The sections on etiology and prophylaxis, as a whole, show a painstaking study of the literature but do not suggest an intimate first-hand contact with the inside of a factory.

Perhaps the most striking evidence of this academic attitude is the small amount of space devoted to dust, ventilation and general factory sanitation as compared with the industrial poisons. The most serious problems of industrial life are accidents and tuberculosis, the industrial poisonings (except plumbism) being by comparison relatively unimportant. Accidents presumably fall outside the scope of this work but certainly industrial tuberculosis does not; yet dust removal and factory ventilation are scantily treated, while pages are devoted to rare intoxications, of interest only as medical curiosities.

Dr. Gilman Thompson's "Occupational Diseases" while preeminently medical in its viewpoint, includes excellent chapters on factory sanitation and dust removal, is in general far better balanced and should prove more valuable for the physician and the average worker in industrial hygiene; Dr. Price's "Modern Factory," while much more elementary and necessarily superficial in certain details, gives by far the clearest picture for beginning students of the entire subject, including accident prevention, and remains the best text-book for social workers, factory superintendents and others who may be interested in the general aspects of the question. "Diseases of Occupation and Vocational Hygiene" contains much material which will make it a valuable reference book for the specialist; but it is not likely to supplant either of the two earlier works, each of which so well fills its special field.

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PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE twelfth number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The Origin of Veins of the Asbestiform Minerals: Stephen Taber, Department of Geology, University of South Carolina. Cross-fiber veins are formed through a process of lateral secretion; the fibrous structure is to be attributed largely to the mechanical limitation of crystal growth through the addition of new material in only one direction.

A New Test of the Subsidence Theory of Coral Reefs: Reginald A. Daly, Department of Geology and Geography, Harvard University. Existing coral reefs are new upgrowths on platforms which have been formed before, and independently of, the reefs. The sub-

marine topography of each reef-platform structure as a whole and the elementary principles of oceanography declare against the assumption that the forms and spatial relations of atoll and barrier reefs are due to the sinking of the earth's crust.

A New Thermometer Scale: Alexander McAdie, Blue Hill Observatory, Harvard University. It is suggested that the absolute zero and the melting point of ice be designated as 0 and 1,000.

On the Immunity Coloration of Some Nudibranchs: W. J. Crozier, Bermuda Biological Station for Research, Agar's Island, Bermuda. The coloration of *Chromodoris zebra* is a metabolic accident, at least in relation to its protection.

Some Effects of the Continued Administration of Alcohol to the Domestic Fowl, with Special Reference to the Progeny: Raymond Pearl. Confirmation of previous calculations that the progeny of alcoholized parentage in poultry, while fewer in numbers, are made up of individuals superior in physiological vigor and that this result is due to a selective action of the alcohol upon the germ-cells.

An Ionization Manometer: O. E. Buckley, Research Laboratory, American Telephone and Telegraph Company and Western Electric Company. Use is made of the ionization of gas by an electron discharge. The range of the apparatus is from 10^{-3} mm. to as low pressures as can be obtained.

Physiological Studies on Rhizophora: Howard H. M. Bowman, Department of Botany, University of Pennsylvania, and Tortugas Laboratory, Carnegie Institution of Washington. The rate of transpiration varies directly with the concentration of the medium in which the Rhizophora plants grow.

On the Hydrogen Ion Concentration of Sea Water, and the Physiological Effects of the Ions on Sea Water: J. F. McClendon, Department of Physiology, University of Minnesota, and Tortugas Laboratory, Carnegie Institution of Washington. It is concluded that OH', $Na^{\cdot}$ and $K^{\cdot}$ increase the permeability of the plasma membrane by causing it to swell and that $Ca^{\cdot\cdot}$, $Mg^{\cdot\cdot}$ and $H^{\cdot}$ (at least on the alkaline side of the isoelectric point) inhibit increase in permeability by inhibiting swelling.

Some Interrelations between Diet, Growth and the Chemical Composition of the Body: Lafayette B. Mendel and Sarah E. Judson, Sheffield Laboratory of Physiological Chemistry, Yale University. Changes in the water, ether extract, and ash content of the body have been determined under various conditions.

Further Study of the Atomic Weight of Lead of Radioactive Origin: Theodore W. Richards and Charles Wadsworth, 3d, Wolcott Gibbs Memorial Laboratory, Harvard University. Atomic weight of four different examples of isotopic lead not hitherto tested was determined, with the results varying from 207.00 to 206.08.

On Some Anomalies in Geographic Distribution of Pacific Coast Mollusca: William Healey Dall, Smithsonian Institution, Washington, D. C. Observations in regard to long-continued studies by the author.

Some Psycho-Physiological Processes as Affected by Alcohol: W. R. Miles, Nutrition Laboratory, Carnegie Institution of Washington. The percentile effects of the ingestion of alcohol upon a related group of processes, such as the patellar reflex latency, lid reflex latency, patellar reflex amplitude, were studied.

The Influence of the Marginal Sense Organs on Metabolic Activity in Cassiopea Xamachana Bigelow: L. R. Cary, Department of Biology, Princeton University, and Department of Marine Biology, Carnegie Institution of Washington. Muscular activity is a relatively unimportant factor in determining the metabolic activity of *Cassiopea.*

New Evidence in Regard to the Instability of Human Types: Franz Boas, Department of Anthropology, Columbia University.

A Revision of the Atomic Weight of Tin: Gregory Paul Baxter and Howard Warner Starkweather, Coolidge Memorial Laboratory, Harvard University. The value $Sn = 118.703$ ($Cl = 35.457$) is found.

Further Studies of Nerve Conduction in Cassiopea: Alfred Goldsborough Mayer, Department of Marine Biology, Carnegie Institution of Washington.

The Earliest Fresh-Water Arthropods: Charles Schuchert, Peabody Museum, Yale University. If the eurypterids and limulids arose in the fresh water we can explain why they and the terrestrial scorpions do not pass through a crustacean stage. It may well be that the trilobites retaining the nauplius stage do not give rise to these stocks. We may look for this ancestral stock in one still more primitive, which seems to have permanently invaded the rivers of the land either in Proterozoic time or in Walcott's Lipalian time.

Observations upon Tropical Fishes and Inferences from their Adaptive Coloration: W. H. Longley, Goucher College, Baltimore. The observations here presented undermine many speculative explanations of animal coloration in terms of natural selection.

Report of meetings of the National Research Council and of its Executive Committee.

Address by Lieut. Colonel George O. Squier, on Scientific Research for National Defense as Illustrated by the Problems of Aeronautics.

Research Grants from the Trust Funds of the Academy.

Report of the Autumn Meeting.

We may summarize the articles in Volume 2 of the *Proceedings* as follows: Mathematics, 20; Astronomy, 29; Physics and Engineering, 23; Chemistry, 15; Geology and Paleontology, including Mineralogy and Petrology, 33; Botany, 9 (see also Genetics); Zoology, including General Biology, 20 (see also Genetics); Genetics, 10; Physiology and Pathology, 13; Anthropology, 10; Psychology, 4; a total of 186 articles.

The division of these articles between members of the Academy and non-members is 63 and 123, respectively.

The list of institutions which have contributed three or more articles is as follows: Harvard, 31; Carnegie Institution, 29, divided as follows: Solar Observatory 19, Marine Biology 3, Station for Experimental Evolution 3, all other departments 4; University of Chicago, 12; Johns Hopkins University, 11; University of California, 7; Yale University, 7; Princeton University, 5; Maine Agricultural Experiment Station, 5; Brown University, 5; Massachusetts Institute of Technology, 5; U. S. Geological Survey, 4; University of Illinois, 4; Smithsonian Institution, 4; Rockefeller Institution for Medical Research, 4; Observatorio Nacional Argentine, 3.

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NOTES ON METEOROLOGY AND CLIMATOLOGY

EVAPORATION MEASUREMENT

Loss of moisture from plant and animal surfaces and from the soil interests the plant physiologists, plant and animal ecologists, and students in agriculture and forestry; but evaporation from a free water surface appeals to irrigation and hydraulic engineers. On this account, a type of instrument satisfactory to the one group will not meet the requirements of the other. Although the rate of evaporation depends primarily on temperature, wind-velocity, humidity, it is a function of the nature of the atmometer as well. For instance, the size, shape, material and color of the pan, the height of the projecting rim, and sediment, color and depth of the water, and the nature of the evaporating surface, affects strongly the evaporation. This being the case, Dr. B. E. Livingston says:[11]

> The ratio of the rate of the evaporation from one kind of atmometer pan to that from another kind remains constant only for some single set of surrounding conditions. Thus the evaporation rate from any atmometer varies with the relation between the internal complex of conditions (nature of the instrument) and the external complex (the surrounding conditions of the atmosphere). . . . The exposure of several evaporating surfaces must be alike if their readings are to be comparable.

The readings of one instrument, therefore, can not be reduced to terms of another.

Although many evaporation observations of various sorts have been taken in the United States,[12] this lack of comparability prevents

[11] *Mo. Weather Rev.*, 43, pp. 126–131, 1915, "Atmospheric Influence on Evaporation and Its Direct Measurement."

[12] T. Russell, "Depth of Evaporation in the

the construction of an accurate chart using these data. It is pleasing, on this account, that Dr. Livingston is distributing standardized porous clap cup atmometers, and that the Weather Bureau has adopted a standard evaporation tank. For special purposes at a given locality any type of atmometer which fills the need is best. Thus, to determine the evaporation from a reservoir surface, several floating pans are used; for the study of evaporation as affecting plant transpiration, some form of water-impregnated paper or a porous clay surface is to be chosen; and for soil evaporation, a box or pan of moist soil is logical.

The porous clay cup atmometer, first suggested by Babinet in 1848, modified by Livingston, Shive and W. L. Tower and again by Livingston, is, in its present form, a spherical clay cup 50 mm. in diameter or a clay plate 77 mm. in diameter attached to a bottle of distilled water.[13] Capillary attraction keeps the cup full of water; and, when it rains, the water is prevented from entering the instrument by means of an ingenious mercury stopper in a bend of the feeding tube. This instrument is adapted especially to studies of plant and animal evaporation. The effect of the sun can be measured by exposing a black and a white bulb side by side. Frequent standardization is necessary, although washing reduces the need. It can not be operated in freezing weather; but this is no drawback for most plant studies. The atmometer is so compact and inconspicuous that it can be exposed with safety almost anywhere.

The Weather Bureau standard is a galvanized open pan four feet in diameter and ten inches deep, which is kept clean and filled with water to a depth of more than seven inches. The top of the pan is some sixteen inches above the ground. With the evaporating pan go anemometer, rain-gauge, and maximum and minimum thermometers. When set up, the whole station is surrounded with a substantial wire fence. By means of a still well, and a micrometer, the depth of the water is read every day at about 7 A.M. local time. All water surface atmometers are subject to the disadvantages (1) of wind action which changes the form of the surface and may blow some of the water out, (2) of the splash of raindrops, and (3) of the interference of animals, birds and insects. Furthermore, the water caught in the standard eight-inch rain-gauge is not necessarily the same as that caught in the tank. With all these errors, it seems a mistake to carry the refinement of measurement to the thousandth of an inch.[14]

While the results of the porous-cup observations and those from the evaporation pans can not be used together, each in the course of time will yield data sufficient for the construction of the first reasonably accurate evaporation maps of the United States.

Extensions of the Weather Bureau Service

Out of the $81,210 increase in the appropriations for the Weather Bureau for the current fiscal year, $50,000 has been designated for extensions of the service. The largest item, $30,000 is to be applied for the increase in weather reports from the West Indies and Central America. It is probable that some 10 new stations will be established, and that closer cooperation between the Weather Bureau and the meteorological services of Cuba and the British colonies will be effected. If these plans are carried out there will be about twice as many stations in this region reporting twice daily to the Central Office during the hurricane season, June 1 to November 30. The shipping using the Panama Canal will be most benefited. During, and for a few years after the Spanish-American War, the Weather Bureau maintained a service almost as extensive as that now planned.

$10,000 is to be used for more complete organization of the weather observation work

United States,'' *Mo. Weather Rev.*, 16, 235–239, 1888. B. E. Livingston, ''A Study of the Relation between Summer Evaporation Intensity and Centers of Plant Distribution in the United States,'' *Plant World*, 14, 205–222, 1911.

[13] Science, N. S., XLI., pp. 872–874, 1915.

[14] Kadel, B. C., ''Instructions for the Installation and Operation of Class 'A' Evaporation Stations,'' Circular L, Instrument division, 1915, W. B. No. 559, 8vo, 26 pp.

in Alaska. Juneau is to become a regular Weather Bureau station and climatological section center. Not only will the climate of Alaska become more fully known but also it is thought that the general weather and storm forecasts for the United States will be helped.

Another $10,000 is to be used in extending the river and flood and the frost-warning services.

The Weather Bureau has recently announced a new civil service examination designed principally for college graduates who are competent to carry on scientific investigation. The initial salary is $1,260 a year.

CHARLES F. BROOKS

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SPECIAL ARTICLES

EXPERIMENTS WITH THE FOUCAULT PENDULUM

1. *Introductory.*—In view of the relatively large angular velocity of the earth, it should be possible to exhibit this rotation by aid of the Foucault pendulum in a few minutes, and this in such a way that reasonably accurate quantitative results may appear. As the pendulum partakes of the rotation of the earth it is not feasible to attach mirrors to the bob, even if this were useful. It is equally clear that the combination of a horizontal pendulum and a Foucault pendulum at its end, or of a large pivoted balance beam with two identical pendulums at its ends will lead to no solution of the problem. In the following note I shall give the results of an optic and of an electric method which I recently had occasion to test and which may interest the reader. A few remarks will also be made on an earth inductor pendulum.

2. *Apparatus.* The question is obviously solved if the swing of the pendulum is regarded with a distant telescope with an ocular micrometer, sighting in the plane of vibration. The equivalent objective result may be obtained if as in Fig. 1, a lens L (not too strong) is placed near the pendulum. The string at rest C is to be at the conjugate focal distance u to the distance v of the screen S from the lens. The string must be strongly illuminated by a Nernst burner N, or sunlight, or the like, and the arc of vibration ab or $cd = D$ must not be so large as to seriously throw the image m of the string at S out of focus. A lens of focal distance of about 60 cm., for a swing D (double amplitude) not larger than 30 cm., does very well. If S is about at 6 meters u will be somewhat short of 70 cm. The pendulum bob should obviously be heavy (3–6 kg.) and the string long (4–5 meters) so that vibration may be slow (period 4 seconds or more), air currents ineffective and observation at S easy.

The vibration is started with the arc ab in the direction of the optical center of L, or otherwise the lens is so placed. In this case the image of the string is stationary at m on the screen. Of course lateral vibration and rotation of the bob around the string as an axis must be scrupulously avoided. This is easily done by letting the bob fall from a lateral hitching cord with one hand after all vibration has been checked by the loose fingers of the other hand, and the image is at m.

The image m soon begins to vibrate right and left more or more fully on the screen S and after the earth has rotated over the angle θ, the point c is replaced by the elongations dd' and the point m has expanded into the elongations at a distance x apart. With a swing of $D = 36$ cm. originally, the distance x increases to nearly 5 cm. in 5 minutes, or about 1 cm. per minute with the dimension of pendulum and lens given above. The rate falls off because the arc D diminishes.

3. *Equation.*—Fig. 1 shows that if θ is the angle of rotation, for the distance x between the elongations at the screen S and the double swing of pendulum $cd = D$, and if the constant $k = u/v$, approximately

$$(1) \qquad \theta' = \frac{u - D/2}{v}\frac{x}{D} = (k - D/2v)x/D,$$

remembering that the angles θ' at c remain small and are initially nearly the same as θ at the center. Furthermore with the same approximation

$$(2) \qquad \theta = \theta'(1 + D/2u) = k(1 - D^2/4u^2)(x/D).$$

Hence after reduction if the rates per hour be dotted

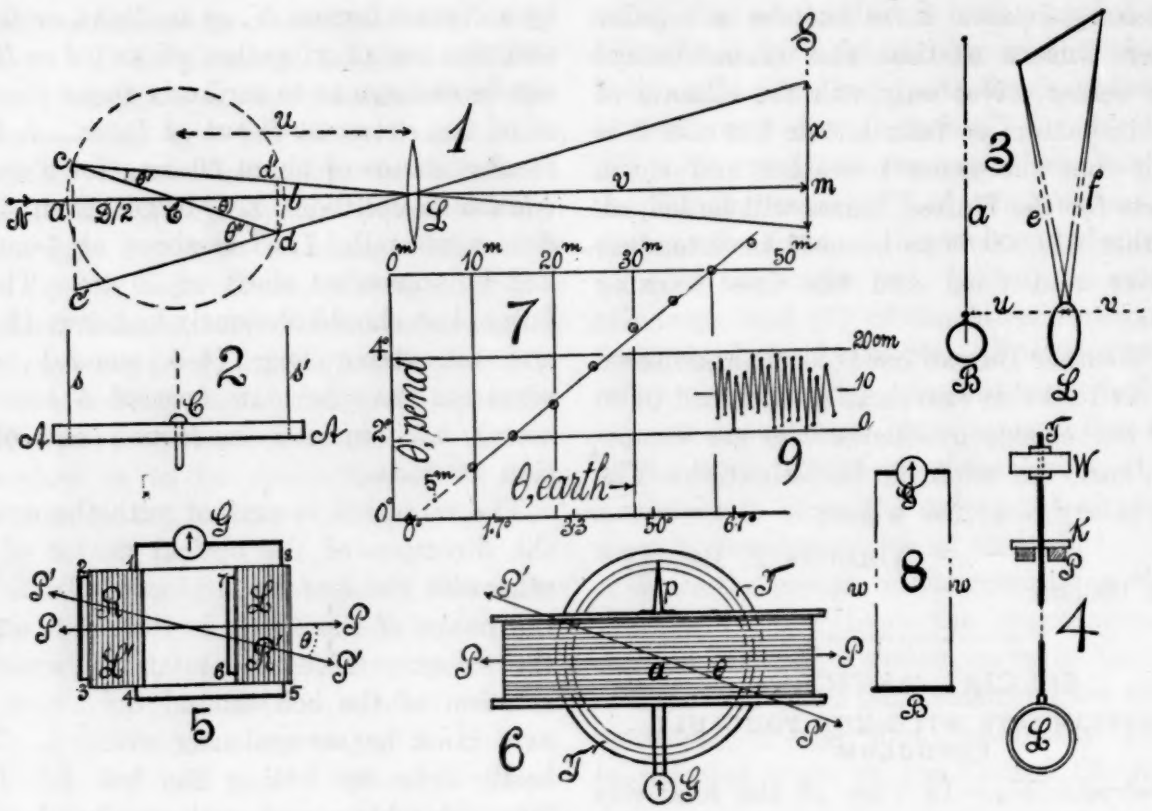

Fig. 1–9

$$\dot{\theta} = k\left\{\left(1 - \frac{D^2}{4u^2}\right)\frac{\dot{x}}{D} - \left(1 + \frac{D^2}{4u^2}\right)\frac{x\dot{D}}{D^2}\right\}. \quad (3)$$

The term in $\dot{D}$ increases rapidly.

Another approximation which is perhaps equally good is much simpler. This consists in regarding the angle θ as the mean of θ' and θ'' in Fig. 1; whence

$$\theta = kx/D. \quad (4)$$

Here k is constant and

$$\dot{\theta} = k\frac{x}{D}\left(\frac{\dot{x}}{x} - \frac{\dot{D}}{D}\right). \quad (5)$$

Values so obtained are usually too large and increase in the lapse of time, whereas values of equation (3) decrease.

4. *Experimental Reduction.*—The difficulty in correcting the results in x by the equation given makes it desirable to standardize the apparatus directly. This may be easily done by aid of a horizontal arm AA, Fig. 2, carrying two fine vertical wires s, s' at a distance $D = 25$ cm. (average arc above) apart, rotating around an axis C over a graduated circle (not shown). The axis C is to coincide with the string of the pendulum, Fig. 1, and the lens L to correspond as before to the conjugate focal distances u and v. In this way the angle θ is directly determined in terms of x at the screen S, apart from all optic considerations. For the dimensions given, s and s' are adequately focused at S. The data show that within an angle less than 10°, θ may be regarded as proportional to x/D.

This method reproduces the actual conditions under which pendulum observations are made and there seems to be no reason for calling the result in question.

Another method consists in finding the magnification by placing a millimeter scale at C, Fig. 1, and measuring its image x at S.

Both these methods have an advantage, as they admit of reducing the individual x, D values to θ values, without requiring differential coefficients.

5. *Observations.*—The first experiments were made with an ordinary plumb bob somewhat lighter than a pound, swinging from a silk thread over 4 meters long. Fair results were obtained but the light bob is not always trustworthy. An example which must suffice here is given in Table I. for an unnecessarily heavy

pendulum bob (4 kg.), swung from a thin brass wire (diameter .7 mm.). Measurements were continued throughout 35 minutes.

TABLE I

Pendulum Observation

Stationary lens, focal distance 60 cm.; diameter 15 cm. Bob 4 kg. on brass wire. (1) Experimentally $\theta_1 = 1°$ equivalent to $x = 3.8$ cm. for $D = 25$ cm. (2) Experimentally $\frac{1}{2}D\theta_2 = 1$ cm. equivalent to $x = 9$ cm. for $D = 25$ cm.; $K_0 = \frac{u}{v} = \frac{68}{603} = .1144$ $\dot{\theta} = 15° \times \sin \phi = 10.01\, \dot{\theta}^{0}/_{h}$ in Providence.

Time, Min.	x, Cm.	D, Cm.	$\dot{\theta}_1$, °/h	$\dot{\theta}_2$, °/h	$\dot{x}$/6 Cm./h	Mean x, Cm.	$\dot{D}$/6 Cm./h	Mean D, Cm.	$\dot{\theta}' + \dot{\theta}'' =$	$\dot{\theta}$
0	1.0	36	—	—						
5	5.8	34	11.2	11.1	8.4	5.2	3.5	3.4	9.2°+.6°=	9.8°
10	9.4	32	10.2	10.1	7.0	9.3	3.5	3.2	8.2 + 1.3=	9.5°
15	12.8	30	10.2	10.2						
20	15.3	29	9.7	9.7						
25	17.8	27	9.7	9.6						
30	20.1	27	9.3	9.3						
35	22.0	25	9.3	9.3						

$\dot{\theta}_1$ from direct measurement of θ and x.

$\dot{\theta}_2$ from direct measurement of magnification: z at u and x at v. $\dot{\theta}' + \dot{\theta}''$ by the general equation (3) § 3. By equation (5), $\dot{\theta} = 10.4°$ and 9.9°, respectively.

The results for $\dot{\theta}_1$ (computed from the direct evaluation of θ, §4) and for $\dot{\theta}_2$ (computed from direct measurement of magnification §4) are practically identical. These data for $\dot{\theta}$ decrease in the lapse of time, definitely. In part this may be ascribed to an insufficiently accurate estimate of the arc D of the pendulum, for which a value derived from the logarithmic decrement might with advantage have been substituted. The high initial value is in part to be associated with an incorrect initial zero. But it is also probable that some secondary disturbance is developing and superimposed on the data for the earth's rotation.

The value of $\dot{\theta}$ found from the equation (4) is given in the second part of Table I. with the mean data used, for the first four observations taken in pairs. It is of about the same order as the others and also gives promise of decreasing.

6. *The Vibrating Lens Pendulum.*—To increase the magnification indefinitely, *i. e.*, to exhibit the rotation θ in shorter time, it will be necessary to use the lens L, Fig. 3, as the bob of a pendulum, swung doubly bifilarly, or in some similar manner, but in such a way as to have the same period as the Foucault pendulum, B. As the bifilar suspension is still liable to vibrate laterally it is unsuitable for this and other reasons. It was therefore replaced by a massive compound pendulum LT, Fig. 4, about a meter long, weighted above with 1.5 or 2 kilograms to secure as long period as that of the Foucault pendulum (4 seconds). The steel knife edge at K should rest on a horizontal flat brass fork P, as it will be necessary to rotate the pendulum slightly around its longitudinal axis LT in the adjustments. The weights W are between screw bolts to regulate the period. The lens L used was an ordinary photographic bullseye lens, 10 cm. in diameter, quite thick and with a focal distance of about 10 cm. The magnification was between 62 and 65.

As the distance between B and L, Figs. 3 and 4, is but 10 cm. the weights W interfere with the string for large arcs of vibration, D. This would have to be modified in a lecture apparatus, for instance by doubling the lens (condenser doublet) or by forking the weights. Furthermore the vibrations of L die down more rapidly than those of B. Since however the pendulum L is weighted above, there is no difficulty in accelerating the lens L cautiously with the fingers when necessary before observation.

In adjusting the apparatus, B must first be quite at rest. The pendulum L is then started, and if the image of the wire of B vibrates on the screen, the lens L is to be rotated on its longitudinal axis, by successive trials, until the image is stationary. Hence the arc traced by the optical center of L passes through the wire of the Foucault pendulum. B is now to be deflected as above and held until the image of the wire is still fixed in the same place, after which B is released with the two pendulums in step. These operations succeed much easier than would be expected.

The results obtained with this apparatus are essentially exhibitional. Thus far 30-minute intervals if x is the mean arc on the screen s and D the mean swing from which, for the

Time	$\dot{x}/2$	Mean x	D
30 min.....	55 cm.	30 cm.	11 cm.
30 min.....	60 cm.	50 cm.	10 cm.

magnification 60, the angles $\dot{\theta} = 9.6°$ and $11.5°$ roughly follow. As the x is equivalent to 2 cm. per minute for the swing $D = 10$ cm. this implies 5 cm. per minute for the usual swing of 25 cm. The experiment is therefore striking, but the necessary interferences make it untrustworthy for absolute values of $\dot{\theta}$. Under all circumstances care must be taken that the lens vibrates without displacing the image of the pendulum wire (at rest), both at the beginning and at the end of the experiment.

7. *Electrical Methods.*—The preceding methods are essentially exhibitional, since the measurements are made from images out of focus. It seems possible however that by the use of the following electrical device a method of precision might eventually be evolved, though this is not attempted in the present paper. In all these cases the pendulum bob is a massive cylindrical magnet weighing .8 kg., 20 cm. long and 25 cm. in diameter, with its axis in the prolongation of the string and its north pole downward. The bob is to be additionally and symmetrically weighted. Its arc of vibration is along PP in Figs. 5 and 6. In case of the former four identical coils R, R', L', L, on a wooden core about 5 cm. square were placed symmetrically to the line PP and just below the magnetic bob. The currents induced in R and R' are guided to counteract those in L and L' in an otherwise continuous circuit, so that the galvanometer at G indicates the differential current. If the system $RR'LL'$ is symmetrical to PP the current in G is zero. If PP deviate to PP' the current in RR' will be in excess. The zero may then be restored by rotating $RR'LL'$ until PP and $P'P'$ coincide. This and other methods were tested, but a more elegant design is given in Fig. 6 in which CC is a long coil with strands of wire wound in the direction of the original arc of vibration PP. The coil which I used was about 30 cm. long wound on a square wooden core 5×5 sq. cm. in cross section, with 6 layers of 34 turns each of copper wire .8 mm. in diameter. The terminals of the coil lead to the galvanometer G, an astatic instrument (preferably), with mirror. The coil CC with the pointer p must be capable of revolving around a vertical axis at a, over the fixed graduated circular plate TT for the measurement of the angle θ in standardizing the instrument.

It is obvious that so long as the pendulum vibrates in the plane PP, the induced electromotive force is normal to the strands of wire and the current at G is zero. When the vibration is oblique, along $P'P'$ for instance, there is a component electromotive force along the strands and the current at G increases rapidly with θ. If the period of the needle is about equal to that of the pendulum the arrangement is quite sensitive and an image of a Nernst filament reflected from the mirror of the needle soon oscillates across a distant wall or screen.

To obtain the current zero, the magnetic bob must oscillate strictly in the vertical plane PP. Any cross vibration or elliptic oscillation at once develops marked currents. Moreover in the course of time it is extremely difficult to obviate the development of these cross vibrations. They would arise if the bob rotates around its own axis, since rigorous rotational symmetry is rarely attained. They would also arise in the reaction of induced currents on the magnetic pole.

The following is a typical experiment among many results. A galvanometer with astatic needles was adjusted by aid of three astisizing magnets placed symmetrically below and on the sides of the needle (strengthening the earth's field) until its period was decreased to 4 seconds, nearly identical with that of the pendulum. In view of this relatively strong magnetic field, the needle was practically free from damping resistances. The experiment was very striking, for with an arc of vibration D between 20 cm. and 25 cm., the vibration of the image of a Nernst filament at first ($D = 25$) increased over 3 cm. per minute.

Table 2 and Fig. 7 is an exhibit of the data obtained when the plane of the pendulum vibration passed through the plane of the coils, x changing from negative to positive values. Unfortunately the undamped needle does not stop vibrating when the intensity of the inductive impulse is reduced to zero; otherwise the rotation of the earth might be directly read off at p, Fig. 6, by rotating the coil on a tangent screw. The reduction factor F in $\theta = Fx$ was measured for 3 arcs: At $D = 24$ cm., $\theta = .054°$, at $D = 14$ cm., $\theta = .087°$ and at $D = 8.7$ cm., $\theta = .111°$, corresponded respectively to $x = 1$ cm.

TABLE II

Electrical Pendulum Registry

$\theta = Fx - .5°$ cylindrical magnetic bob, length 20 cm., diam. 2.5 cm., mass 800 grams. Long square coil, 6 layers, 34 turns each, 30 cm. long, 5 cm. broad, 5 cm. high within. Bob and astatic needle of galvanometer with synchronized period of 4 sec.

t, Min.	D, Cm.	$F \times 10^3$	x, Cm.	θ, Deg.	$\dot{\theta}$, °/Hour
0	22	60	−19	—	—
5	19	70	(7)	(.00)	—
10	16	80	16	.78	9.4
15	14	85	24	1.54	9.2
20	13	90	31	2.29	9.2
25	11	100	37	3.20	9.6
30	10	105	44	4.12	9.9
35	9	110	48	4.78	9.6
40	8	115	52	5.48	9.4
45	7	125	53	6.13	8.2

For other arcs D the reduction factor F was interpolated. When x is negative, the arcs x are in excess of the electromotive impulses which are decreasing toward zero. When x is positive the arcs are in deficiency of the increasing impulses due to the rotation of the earth. Hence an undamped needle does not come to rest and in Table II. and Fig. 7, $\theta = 0°$ at $t = 2$ min. was interpolated (parenthesis) from the subsequent 8 data. This makes $\theta = Fx - .5°$, beginning with $t = 5$ min. The fluctuations of $\dot{\theta}$ are due to the rough measurement of D and the correspondingly rough value of the reduction factor F and are quite as good as anticipated. Eventually the decrement of x due to decreasing arc D must begin to approach the increments due to the earth's rotation, whereupon x will be stationary. This seems to happen after 45 m. in Table II.

Again if the reduction factor F of x is taken constant throughout, the results show the rapidity with which the θ values fall off even after 10 minutes. Thus it seems that a compound pendulum on knife edges, Fig. 4, with the magnetic bob similarly placed to the coil must be used for standardization.

In other series experiments the reduction from x to θ was made linearly, the constants being a mean approximation from a direct measurement of x and θ. This however is the real difficulty of the method and is far from satisfactory owing to the development of cross vibrations.

In the final results the case of a core of 4 iron plates (each 18 cm. × 25 cm. × .044 cm.) placed symmetrically within the coil was tested. In view of the breadth of these plates and the weight of the pendulum there was supposed to be no danger from induction. The sensitiveness (scale at 4 meters) was thus increased to an initial growth of $x = 5$ cm. per minute of earth rotation. It would have been larger if the periods of pendulum and needle had been as nearly the same as before. Here I found roughly $\theta = Fx = (.110 - .0035D)x$ and it was interesting to note that for the last data the term in Dx had passed through a maximum. Hence the increments of x are much reduced. If the logarithmic decrement is used, $\dot{\theta} = 60(a - bD_0c^{t/5})x$ degrees per hour, follows, where a and b are the constants given, $D = 27$, $c = .896$. Greater smoothness is thus obtained, but the real difficulty which resides in the constants a and b is left untouched. Finally one may note that the data with a plate iron core in the coil were apparently as good as those obtained without; for the correction coefficients which indicate the growth of cross vibrations were actually larger (accidentally) in the absence of iron.

8. *Short Pendulum.*—The endeavor was now made to use the same method for a short pendulum. For this purpose the magnetic cylinder was swung on a round glazed fish line.

To secure an adequate suspension the top of the cord was first passed through a snugly fitting hole in a fixed wire draw-plate and then attached to the shaft of a strong fixed horizontal screw, above. On turning the screw the bob could be raised or lowered at pleasure or secured in any position in virtue of the friction of the screw. An old Kohlrausch galvanometer with elliptic coils and a magnetized steel mirror in a copper damper at its center was found very serviceable. By placing the astisizing magnet in different positions with or against the earth's field, the periods could be usefully varied from 1 second to over 6 seconds.

Pendulums ½ to 1 meter in length were first suspended from a single massive rigid standard; thereafter from a gallows between two massive standards, carefully braced. In neither case was I able to eliminate to development of elliptic vibrations, however, resulting either from the action of the induced currents on the magnetic bob (an effect to be anticipated) or from vibrations at the suspension. I did not therefore attempt to carry out measurements, although from the rapid motion, the sensitiveness was very marked, $\theta = .06°$ to $.03°$ per $x = 1$ cm. being easily available. A rotational effect should therefore be observable in 10 sec. The whole experiment is an interesting one, regarded either in its present bearing, or as an illustration of a vibrating system of two degrees of freedom, or of the laws of induction.

9. *The Bifilar Inductor Pendulum.*—Though not immediately connected with the present subject, the following striking experiment uses similar synchronized apparatus. A long (1–2 meters) brass or copper rod or bob, *B*, Fig. 8, is swung horizontally from two thin vertical brass wires *ww* attached at the ends of the rod and to the ceiling, or elsewhere. These thin wires are the terminals of the synchronized galvanometer, *G*, and the brass rod swings parallel to itself, cutting the earth's vertical magnetic field, H_v, normally. The mean horizontal speed, $\dot{y}$, of the rod may be written in terms of the maximum speed, $\dot{y}_0$ (simple harmonic motion) as $\dot{y} = 2\dot{y}_0/\pi$ and if a is the amplitude of the pendulum, T its period, l its length, g the acceleration of gravity, e is the mean electromotive force induced and b the length of brass rod (bob),

$$e = \frac{2abH_v}{\pi \times 10^8}\sqrt{\frac{g}{e}} \text{ volts.}$$

In my pendulum

$a = 20$ cm., $b = 100$ cm., $H_v = .4$, $l = 400$ cm., whence

$$c = 8 \times 10^{-6} \text{ volts nearly.}$$

Thus it should be possible to measure e with a moderately sensitive galvanometer, particularly so if its period is the same as that of the pendulum.

Incidentally one may observe that if a horizontal wire 10 meters long is moved normally through the earth's vertical field with a speed of 2 kilometers per minute, as on a flying machine, the difference of potential at the ends would be over $e = 10^{-2}$ volts. The latter would have to be measured electrostatically, however, with an artificial earth like a large insulated condenser. If this can be done, it would suggest a method of registering the speed of the machine.

A number of experiments were made with the above pendulum ($T = 4$ seconds) and the synchronized Kohlrausch galvanometer, of which Fig. 9 gives an example. The needle of the galvanometer was not at rest, owing to the proximity of trolley wires and the astasized *simple* needle. Hence the fluctuations at the two elongations. But apart from this, the result is about $x = 7$ cm. between elongations per meter of length of the bob of the bifilar pendulum and a double amplitude of the latter of about $D = 40$ cm. (screen at 4 meters). A shorter pendulum, an astatic needle and an external magnet strengthening the earth's field at the galvanometer, would give smooth results. D could be much increased, etc. It is also obvious that a long rectangular coil similar to the bifilar and on knife edges could be used to multiply the effect of the single bifilar circuit.

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SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and eighty-ninth regular meeting of the society was held at Columbia University on Saturday, February 24. The morning session sufficed for the presentation of the brief list of papers. The attendance included twenty-six members. Professor H. S. White occupied the chair, being relieved by Professor Kasner. The council announced the election of the following persons to membership in the society: Professor H. P. Kean, McHenry College; Mr. Ralph Keffer, Harvard University; Mr. H. C. M. Morse, Harvard University; Dr. F. D. Murnaghan, Rice Institute; Mr. G. E. Raynor, University of Washington; Dr. S. P. Shugert, University of Pennsylvania; Mr. G. W. Smith, University of Illinois; Mr. J. S. Taylor, University of California; Dr. L. E. Wear, University of Washington; Dr. H. N. Wright, University of California. Four applications for admission to membership were received.

It was decided to hold the next summer meeting of the society at Cleveland, Ohio, on September 4–5. The Mathematical Association of America will meet at Cleveland on September 6–7.

By the will of the late Professor L. L. Conant, of the Worcester Polytechnic Institute, who was a member of the society from 1892 to his death in 1916, the sum of $10,000 is left to the society, subject to Mrs. Conant's life interest. The will provides that the income of this bequest "shall be offered once in five years as a prize for original work in pure mathematics." This generous gift, a noble monument to the donor, should do much for the promotion of higher mathematical aims in this country. For many years the society has consistently pursued these aims, with a success far outrunning what might have been expected from its modest financial resources. With greater means in the way of general or special funds, it could accomplish still more. To anyone who is able to give for science, the society presents itself as an experienced and beneficent administrator.

At the annual meeting, the council placed itself on record as desiring to cooperate with the National Research Council in forwarding the interests of research. At the February meeting a committee was appointed to confer with the chairman of the Mathematics Committee of the Research Council, Professor E. H. Moore, in regard to the selection of the members of that committee.

The following papers were read at this meeting:

A. R. Schweitzer: "The iterative compositions of a function of $n+1$ variables ($n=1, 2, 3 \dots$)."

A. R. Schweitzer: "Functional equations based on iterative compositions."

D. F. Barrow: "An application of Fourier's series to probability."

Edward Kasner: "Degenerate cases in the theory of the conduction of heat."

J. E. Rowe: "The equation of a rational plane cubic derived from its parametric equations (second paper)."

R. L. Moore and J. R. Kline: "The most general closed plane point set through which it is possible to pass a simple continuous plane arc."

H. S. White: "New proof of a theorem of von Staudt and Hurwitz."

Henry Taber: "On the structure of finite continuous groups."

The next meeting of the society will be held at the University of Chicago on April 6–7. The San Francisco Section will meet at Stanford University on April 7.

F. N. COLE,
Secretary

OKLAHOMA ACADEMY OF SCIENCE

THE Oklahoma Academy of Science held its eighth annual meeting in Oklahoma City, December first and second, with President C. N. Gould in the chair. The following papers were presented:

AGRICULTURE

"Effects of Soil Types on the Root Development of Cotton and Kaffir," by Wallace MacFarlane.

ARCHEOLOGY

"Types of Stone Implements," by J. B. Thoburn.

CHEMISTRY

"Errors in the Determination of the Coefficient of Viscosity Gases by the Capillary Method," by I. M. Rapp.

"Sulfur in Petroleum," by Chas. K. Francis.

"Effect of Para Substituents in the Acylation of Aromatic Amines," by L. Chas. Raiford and A. F. Whipple.

"Oxidation of Ethyl Alcohol to Acetaldehyde," by Wm. J. Becker.

"Infra-red Absorption of Naphthalene," by A. H. Stang.

"Visibility Curves of the Green Mercury Line and Its Satellites," by A. F. Reiter.

ECONOMICS

"Setting the Clock Ahead," by Joseph M. Perkins.

"The Lumber Industry of Oklahoma," by John Cullen.

EDUCATION

"The Educational Survey," by T. Earl Sullinger.

"Seeing Oklahoma," by C. W. Shannon.

"The Teaching of Physiography and Geography in Our Common Schools," by C. W. Shannon.

ENGINEERING

"Oklahoma City's New Water Plant," by W. L. Benham.

"Appraisal of Public Utilities" (by title), by A. L. Mullergren.

GEOLOGY

"The Practicality of Using the Diamond Drill in Exploring for Oil and Gas Structures," by Geo. E. Burton.

"New Anticlines," by Chas. N. Gould.

"Concretions in Caddo County," by Chas. N. Gould.

"Origin of the Ferruginous Sandstones of Southeastern Oklahoma," by Chas. W. Honess.

"The Occurrence of Coal in Cimarron County," by Fritz Aurin.

"Progress of Work in the Cretaceous Area of Oklahoma," by C. W. Shannon.

"New Volcanic Ash Theory," by Chas. N. Gould.

"Manganese Deposits Near Bromide, Oklahoma," by Geo. E. Burton.

"The Distribution of the Sand Dunes of Oklahoma," by Bryan Hendon.

"Oil Seeps," by Elbert E. Boylan.

"A 'Gas Blow-out,'" by V. V. Waite.

"The Elephants of Oklahoma" (by title), by E. B. Wilson.

"The Early Vertebrates of Oklahoma" (by title), by M. G. Mehl.

"Granite Situation in North-Central Kansas" (by title), by Everett Carpenter.

MATHEMATICS

"English Experiences in Teaching Calculus to Trades-school Students," by A. Press.

"A Shorter Proof of a Theorem on Fourier's Series" (by title), by W. H. Cramblet.

BIOLOGY

"A Flock of Hawks," by Chas. N. Gould.

"*Platanus occidentalis*," by Chas. N. Gould.

"Past and Future of the Buffalo," by Frank Rush.

"Reproductive Organs of Birds and Their Activities" (by title), by T. C. Carter.

"Biological Significance of Bones, Teeth and Shells Found in the Caves of Eastern Oklahoma," by H. H. Lane.

"Further Observations on the Effect of Acohol on White Mice," by L. B. Nice.

"Speech Development of a Child from Eighteen Months to Six Years," by Mrs. Margaret Morse Nice.

"The Murine Opossum, an Accidental Immigrant in Oklahoma," by H. H. Lane.

"On a Collection of Moths and Butterflies from Costa Rica," by H. H. Lane.

"Some Personal Observations on the Habits of the Butcher's Shrike," by C. W. Shannon.

"Observations on *Demoder folliculorum*" (by title), by G. K. Stanton.

"The Relation of Vegetation to Stratigraphy" (by title), by Floyd Absher.

"The Hawks of Oklahoma" (by title), by Joe Matthews.

The Committee on Publications reported that arrangements had been made whereby the University of Oklahoma would assume responsibility for publishing the proceedings, the academy paying what it can and the state assuming the balance. The report was accepted. The committee appointed on publication for the coming year consists of the president, treasurer, secretary and curator.

The committee on membership presented the names of forty new members which were accepted.

Professor C. W. Shannon, director of the Oklahoma Geological Survey reported that the Biological Survey working in connection with the academy had established many nature study clubs in the public schools of the state during the past year. Report accepted.

A committee was appointed to work to get better laws passed in Oklahoma for the protection of wild life. Mr. Frank Rush, United States forester, in charge of the buffalo herd, in the Washita Mountain Reservation, was made chairman of this committee.

The treasurer's report was read and accepted.

The following officers were elected for the coming year:

President, L. Chas Raiford, A. & M. College; *First Vice-president*, M. M. Wickham, Southeastern State Normal School; *Second Vice-president*, A. F. Reiter, Phillips University; *Treasurer*, H. H. Lane, University of Oklahoma; *Secretary*, L. B. Nice, University of Oklahoma; *Curator*, Fritz Aurin, Oklahoma Geological Survey.

L. B. Nice,
Secretary